

BOERHAVIA TRIQUETRA VAR. INTERMEDIA (NYCTAGINACEAE); A NEW
COMBINATION AND VARIETAL STATUS FOR THE WIDESPREAD
SOUTHWESTERN NORTH AMERICAN *B. INTERMEDIA*

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ABSTRACT

The name for the poorly known, narrowly distributed, *Boerhavia triquetra* S. Wats. predates the name *B. intermedia* M.E. Jones, a well-known widespread species of the arid American Southwest. A survey of herbarium specimens and recently collected specimens from the type locality of *B. triquetra* at Bahía de los Angeles in Baja California, shows the two taxa to thoroughly intergrade. The nomenclatural combination ***Boerhavia triquetra*** S. Wats. var. ***intermedia*** (M.E. Jones) Spellenb. is proposed. A key distinguishing this variety and the var. *triquetra* is presented.

RESUMEN

El nombre de la poca conocida *Boerhavia triquetra* S. Wats., de distribución limitada, precede el nombre *B. intermedia* M.E. Jones, una especie bien conocida y de distribución extensa en el suroeste árido de Norte América. Una revisión de muestras de *Boerhavia* en herbarios y las muestras recogidas recientemente en la localidad del tipo en Bahía de los Ángeles, Baja California, demuestran que los dos taxa intergradan completamente. Se propone la combinación nomenclatural ***Boerhavia triquetra*** S. Wats. var. ***intermedia*** (M.E. Jones) Spellenb. Se presenta una clave que distingue esta variedad y la var. *triquetra*.

In 1902 M.E. Jones described an annual *Boerhavia* from El Paso, Texas, U.S.A., as *Boerhavia intermedia* M.E. Jones. Prior to that time this taxon was included in a broadly conceived *B. erecta* L., the name under which Jones first distributed his collections of *B. intermedia*. For example, Gray (1853) concluded his review of Wright's collections of *Boerhavia* by noting that other species in his collection, apparently with annual roots, had been distributed as *B. erecta* L. The outward similarity of this desert annual, *B. intermedia*, to the more mesic and tropical *B. erecta*, is often noted (e.g., Kearney and Peebles 1960) and has resulted in a combination of the former as a variety in the latter (*B. erecta* var. *intermedia* (M.E. Jones) Kearney & Peebles). Molecular evidence suggests, however, that *B. erecta* and *B. intermedia* are not particularly closely related (Norm Douglas, pers. comm. 2007). *Boerhavia intermedia* as understood by Standley (1918) and Spellenberg (1993, 2003), among other authors of regional floras, is widespread and variable, occurring throughout the warm, arid regions of northwestern Mexico and southwestern United States. The only attempt to taxonomically address the variation through taxonomic division of this taxon was *B. universitatis* Standl., from Tucson, Arizona (Standley 1909), since shortly after its inception a name consistently considered a synonym of *B. intermedia*. Though not explicitly stated by Jones (1902) or Standley (1909), *B. intermedia* has been understood to have truncate fruits with five angles separated by rugose sulci.

In 1889 S. Watson described *B. triquetra* S. Wats. from a collection of plants made by E. Palmer, the type originating from near Bahía de los Angeles, Baja California, Mexico. It was distinguished from other *Boerhavia* by its 3–4-angled truncate fruits with rugose sulci. Since that time the distinction between *B. intermedia* and *B. triquetra* in regional floras has not been clear. Both are distinguished from other *Boerhavia*, and allied to one another, by their annual habit and narrowly obdeltate (in profile) ribbed (not winged) fruits with pedicels that join in a terminal umbel. Those with umbels reduced to solitary fruits still differ from other *Boerhavia* by the habit and fruit shape, though the distinction between *B. intermedia* and *B. erecta* is then subtle.

Wiggins (1964) separated the two species in his key primarily by flowers solitary or in umbellate or

close cymules. He noted the fruit to be 3–5 angled in *B. triquetra*, 5 angled in *B. intermedia*, the fruit of the former slightly broader. Annual *Boerhavia* of the very dry Mojave and western Sonoran deserts of southeastern California and adjacent Sonora often have one fruit per peduncle and have been called *B. triquetra* on specimens. Spellenberg (1993) attempted to distinguish the two taxa by numbers of fruit per cluster, and a subjective aspect of inflorescence structure, making no reference to rib number. In 2003 Spellenberg maintained *B. intermedia* and *B. triquetra*, noting in discussion that the distinction between the two seemed moot. The hesitancy to combine the two names in 2003 into one taxon was reinforced by Spellenberg not having seen *B. triquetra* (which has priority over *B. intermedia*) in the field. In addition, the application of *B. triquetra*, a name for a poorly known taxon from a very limited region, was not descriptive for the widespread well-known species with usually 5-sided fruits. Nevertheless, in preparing the treatment of the Nyctaginaceae for the Jepson Manual, 2nd edition, Andrew Murdock (at UC Berkeley) came to the conclusion that the two names apply to one taxon in California (pers. comm. 2006).

In October, 2006, I spent several days in the vicinity of Bahía de los Angeles. Late summer rains had been good, and small collections of *Boerhavia* were made, as were observations. Those collections have been deposited at HCIB and NMC. Including these specimens and those deposited in herbaria, 71 collections from throughout the range of both taxa were examined for numbers of fruit per terminal cluster, fruit size, rib number per fruit, and pedicel length. The following observations were made.

Pedicels vary from 0.2 to 3.2 mm throughout the range, the shortest occurring within the confines of the Sonoran Desert, but longer (± 1.7 mm) common within the region also. Watson (1889) noted the pedicels of *B. triquetra* to be very short (ca. $\frac{1}{2}$ line [= $\frac{1}{24}$ " = ca. 1 mm]). My own collections from around the Bahía de los Angeles had pedicels 0.2–1 mm long; to the north and to the south along the eastern side of the peninsula in this region pedicels ranged to 1.3–1.9 mm long. Elsewhere they were as short as 0.3 mm.

On plants with sufficient fruiting peduncles the number of fruits in 10 umbels was counted. Numbers of fruits per umbel ranged from 1–22. Those with single fruits per umbel occurred throughout the range, but were particularly common in the deserts of southern California. Those with the highest number were from the coast of Sonora. Number of fruits per umbel commonly was 1–5 in the vicinity of Bahía de los Angeles; one plant which had consistently 1 fruit/umbel had only 5-sided fruits (Spellenberg 13790, below). No particular difference between fruit number in this region versus other areas was obvious, except that in Chihuahua, Coahuila and Durango fruit number commonly was 3–7 per umbel, with 1-fruited umbels less frequent.

Plants with primarily, or entirely, 1-fruited umbels from throughout the Southwestern warm deserts are represented by the following collections (here and throughout all specimens at NMC unless otherwise cited (herbarium citations from Holmgren and Holmgren, <http://sciweb.nybg.org/science2/IndexHerbariorum.asp>): **AZ, Pinal Co.**, San Tan Mts. Regional Park, *Damrel and Damrel* 24716; **BC, Mcpio. Ensenada**, on road to Bahía de los Angeles 37 km E of Hwy 1, *Spellenberg* 13790; *Roos s.n.*, **CA, San Bernardino Co.**, Big Morongo Reserve, in Big Morongo Canyon, *Helmkamp B-19*, UTEP; **Riverside Co.**, Chuckawalla Mts. 2.5 mi SE of Desert Center, 23 Oct 1963, UTEP; **NM, Doña Ana Co.**, ca 10 mi E of Las Cruces, W base of Organ Mts., *Spellenberg* 2921. All these had only five-sided fruits. Three- and four-sided fruits were found on *Sanders 051* and *Van Devender & Reina G. 2000-939* (citations end of next paragraph), both of which had few fruits per umbel (1–2 fruits, av. 1.6; 1–4 fruits, av. 2.5, respectively). Of note is that the very earliest inflorescences on many plants have 1 or few fruits, as often do very late inflorescences. The preponderance of few-fruited umbellate plants on the Mojave and western Sonoran deserts may simply be selection for this early-development feature in an area of unpredictable and reduced summer moisture.

Fruit size did not seem to differ much from one part of the range to the other. Within the Bahía de los Angeles region fruits were 2.0–2.8 mm long; slightly to the south fruits reached 3 mm long. Elsewhere fruits were 2.0–3.1 mm long. The range of fruit width is less in the vicinity of Bahía de los Angeles (the length/width ratio equalling 1.5–2.0) than for plants from throughout the range of *B. intermedia* (l/w = 1.3–2.7). The proportionately broadest fruits are from a plant that has only 3- and 4-sided fruits from Sonora (**SON, Mcpio. Hermosillo**, Playa Esthela just N of Bahía de Kino, *Van Devender & Reina G. 2000-939*). A similar

plant with only 4-sided fruits (and 1 fruit with a poorly developed 4th side, i.e., almost 3-sided) had fruits with $l/w = 1.9$ (**CA, Imperial Co.**, Julian Wash, E of Peter Kane Mt., *Sanders 051*).

Numbers of sides on the fruits varies throughout the range of *Boerhavia intermedia*. An attempt was made to count all scorable fruits on a plant unless there were hundreds available, and then counting was haphazard, i.e. without intentional bias. Outside the Sonoran Desert plants bear mostly 5-sided fruits, but there are occasional fruits with 4 sides. In the following the numbers of fruits counted on any one plant are given in the sequence 5-, 4-, and 3-sided as, for example, **CHIH**, 1 mi S of Camargo, (53, 10, 0) *Henrickson 7735*; **CHIH**, 7 mi S of Ojinaga, (74, 1, 0), *Spellenberg & Spellenberg 3699*; **COAH**, 4 km S of Las Margaritas, (38, 2, 0), *Chiang et al. 9519c*; 14 mi NW of San Pedro, (56, 3, 0), *Henrickson 5975*; **NM, Doña Ana Co.**, 15 mi N of Las Cruces, (92, 7, 0), *Spellenberg 2649*; **TX, Presidio Co.**, 24.9 mi E of Redford, (31, 1, 0), *Spellenberg 3710*.

In the Sonoran Desert, excluding central Baja California (reviewed below), plants have 5-sided fruits, or mostly 5-sided fruits with some 3- or 4-sided fruits. Examples of those with some 3- and 4-sided fruits are: **AZ, La Paz Co.**, (49, 1, 1), *Spellenberg 7864*; **Pinal Co.**, (152, 3, 0), *Spellenberg 13271*; **SON, Mcpio. Empalme**, 1.9 km NW of MEX 15 on Empalme-Guaymas bypass, (79, 8, 0), *Reina G. et al. 2002-1055*; 25 km S of Empalme (98, 14, 1 [1 fruit with 9 ribs]), *Spellenberg & Douglas 13317*. **Mcpio. Guaymas**, 1 mi E of San Carlos Bay, (45, 2, 0) *Spellenberg et al. 2688*; 4 mi. W of San Carlos, (35, 2, 0) *Spellenberg et al 2693*; 4 mi W of San Carlos, (30, 2, 1), *Spellenberg et al. 2694*; Guaymas, Colonia La Peninsula, (71, 1, 0), *Spellenberg & Willson 3632*; 4.6 km W of San Carlos, (45, 4, 0), *Spellenberg 13811*. **Mcpio. Hermosillo**, ca.10 mi S of Hermosillo, (90, 6, 0), *Spellenberg et al. 2683*. **Mcpio. Moctezuma**, 18.9 km SSE of jct with Moctezuma-Huásabas Hwy, (43, 1, 0), *Van Devender & Reina G. 2006-801*. Plants with 3- and 4-sided fruits, usually among 5-sided fruits on the same plant, are most common at low elevations on the Sonoran Desert around the northern portion of the Gulf of California, and plants with the greatest proportion of 3- and 4-sided fruits are found here also.

To the north and south of Bahía de los Angeles, on the eastern side of Baja California, numbers of sides per fruit also varies widely: **Mcpio. Ensenada**, ca 16 km S of Puertocitos, (22, 0, 0) *Spellenberg 13783*; ca. 30.5 km S of Puertocitos, (38, 0, 0) *Spellenberg 13784*; 13.5 km N of Punto Bufo, (92, 4, 1) *Spellenberg 13785*. **Mcpio. Mulegé**, 8 km W of Santa Rosalia, (29, 0, 0) *Spellenberg 13803*; ca. 1.5 km S of Santa Rosalia, (7, 14, 6), *Spellenberg 13805*; ca. 1.5 km S of Santa Rosalia, (41, 0, 0) *Spellenberg 13806*; 4.6 km N of Mulegé, (plant A = 158, 0, 0; plant B = 56, 2, 0) *Spellenberg 13807*. It is noteworthy that 13805 and 13806 were within 100 m of each other. Other collections from the general region: **Mcpio. La Paz**, Isla San José, *León de la Luz 9409a*, (25, 0, 0); Sierra la Giganta, *Moran 18860* (60, 2, 0). **Mcpio. Mulegé**, Sierra la Giganta, *Carter 4859*, (47, 2, 0).

These results are compared with sampling from in the immediate Bahía de los Angeles (BLA) region on the eastern side of Baja California: **BC, Mcpio. Ensenada**, road to BLA 37 km E of Hwy 1, (57, 0, 0) *Spellenberg 13790*; 4.3 km W of BLA, (82, 51, 6) *Spellenberg 13791*; BLA, (30, 4, 0) *Spellenberg 13792*; 4.5 km S of BLA (33, 95, 39) *Spellenberg 13793*; 1.6 km N of BLA, (70, 16, 0) *Spellenberg 13795*; 6.4 km W of BLA (plant A = 4, 15, 21; plant B = 17, 8, 3) *Spellenberg 13799*. This last collection was taken from a crowded population of plants in an arroyo bottom that did not differ noticeably among one another with regard to habit or fruit number per umbel, but these were selected from among those that bore mostly 5-sided fruits. Counts from the type specimens (*Palmer 521*, Lower California, Los Angeles Bay in 1887) are: (1, 18, 21) US 933319; (8, 60, 89 – from a count of fruits in packet made in 2001) US 933313; (1, 24, 23) US 22954; (0, 4, 6) UC 101261. Though I was able to find many plants that had a habit very similar to the types of *B. triquetra* around Bahía de los Angeles, none that I found had proportions of 3- and 4-sided fruits as high as in the types.

A broad survey of plants known as *B. intermedia* and *B. triquetra* revealed no differences that unequivocally distinguish the two. Fruit size, rib number and rugosity are similar, and differences are variable and overlapping. Stems may be more widely spreading in some populations from Baja California, but erect plants occur there also. Plants may be more strongly ascending to the east, but widely spreading plants also occur. It is proposed that the two names be considered to apply to a single species with two highly intergradient varieties, requiring a new combination:

Boerhavia triquetra S. Wats. var. ***intermedia*** (M.E. Jones) Spellenb., comb. nov. *Boerhavia intermedia* M.E. Jones, Contr. W. Bot. 10:41. 1902. *Boerhavia erecta* L. var. *intermedia* (M.E. Jones) Kearney & Peebles, J. Wash. Acad. 29:475. 1939. TYPE: TEXAS: El Paso, 10 Sep 1883, M.E. Jones 4173 (LECTOTYPE, designated by Reed, Flora of Texas 211. 1969; US 223742! ISOLECTOTYPES: POM!). Reed lectotypified this name in his treatment of Nyctaginaceae for Texas when he specifically cited the US specimen as the type.

Boerhavia universitatis Standl. Contr. U.S. Natl. Herb. 12:380. 1909. TYPE: ARIZONA: Tuscon, Campus Univ. of Arizona, alt. 740 m, 2 Sep 1903, *Thornber s.n.* (HOLOTYPE: ARIZ! ISOTYPES: MO! US!).

The two varieties may be distinguished as follows. The var. *triquetra* is restricted to low elevations (0–300 m) in the Sonoran Desert around the Gulf of California. The var. *intermedia* is widespread in Mojave, Sonoran, and Chihuahuan deserts, including low elevations around the Gulf of California. Though the key below seems to allow for a potentially large number of intergradient plants, no plants in the sample that I observed fall within the range of bearing 50–80% 5-sided fruits.

1. 50% or more of the fruits on a plant 4- or 3-sided _____ ***B. triquetra* var. *triquetra***
2. 80% or more of the fruits on a plant 5-sided _____ ***B. triquetra* var. *intermedia***

Four other named *Boerhavia* are either part of, or very closely related to, this complex. Two are narrow endemics with the ribs expanded into broad wings, *B. alata* S. Wats., from the islands around Guaymas, Sonora, and *B. megaptera* Standley, from south-central Arizona. Two others are poorly distinguished from *B. triquetra* var. *intermedia*. One, *B. maculata* Standley, from the coast of southern Sonora and adjacent Sinaloa, has larger and proportionately broader 5-ribbed fruits and comparatively large flowers in 1–2-flowered umbels. Except for its larger flowers, a feature common among these annual *Boerhavia* that grow along the Sonoran coast, it resembles other *Boerhavia* specimens with few-flowered umbels taken at low-elevation from around the Gulf of California. The other, *B. lateriflora* Standley from the vicinity of Guaymas, Sonora, has large inflorescences of dense head-like cymes or compound umbels. A suitable disposition of these names may be revealed by critical study of molecular and population variation.

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